



## Projected effects of climate change on tick phenology and fitness of pathogens transmitted by the North American tick *Ixodes scapularis*

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### Abstract:

*Ixodes scapularis* is the principal tick vector of the Lyme borreliosis agent *Borrelia burgdorferi* and other tick-borne zoonoses in northeastern North America. The degree of seasonal synchrony of nymphal and larval ticks may be important in influencing the basic reproductive number of the pathogens transmitted by *I. scapularis*. Because the seasonal phenology of tick vectors is partly controlled by ambient temperature, climate and climate change could shape the population biology of tick-borne pathogens. We used projected monthly normal temperatures, obtained from the second version of the Canadian Coupled Global Climate Model (CGCM2) under emissions scenario A2 of the Intergovernmental Panel on Climate Change for a site in southern Ontario, Canada, to simulate the phenology of *I. scapularis* in a mathematical model. The simulated seasonal abundance of ticks then determined transmission of three candidate pathogens amongst a population of white-footed mice (*Peromyscus leucopus*) using a susceptible-infected-recovered (SIR) model. Fitness of the different pathogens, in terms of resilience to changes in tick and rodent mortality, minima for infection duration, transmission efficiency and particularly any additional mortality of rodents specifically associated with infection, varied according to the seasonal pattern of immature tick activity, which was different under the temperature conditions projected for the 2020s, 2050s and 2080s. In each case, pathogens that were long-lived, highly transmissible and had little impact on rodent mortality rates were the fittest. However, under the seasonal tick activity patterns projected for the 2020s and 2050s, the fitness of pathogens that are shorter-lived, less efficiently transmitted, and more pathogenic to their natural hosts, increased. Therefore, climate change may affect the frequency and distribution of *I. scapularis*-borne pathogens and alter their evolutionary trajectories.

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### Resource Description

#### Climate Scenario :

specification of climate scenario (set of assumptions about future states related to climate)

Special Report on Emissions Scenarios (SRES)

**Special Report on Emissions Scenarios (SRES) Scenario:** SRES A2

#### Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other

# Climate Change and Human Health Literature Portal

elements of climate change to prevent harm to health

A focus of content

## **Exposure :**

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Temperature

**Temperature:** Fluctuations

## **Geographic Feature:**

resource focuses on specific type of geography

None or Unspecified

## **Geographic Location:**

resource focuses on specific location

Non-United States

**Non-United States:** Non-U.S. North America

## **Health Impact:**

specification of health effect or disease related to climate change exposure

Infectious Disease

**Infectious Disease:** Vectorborne Disease

**Vectorborne Disease:** Tick-borne Disease

**Tick-borne Disease:** General Tick-borne Disease

## **Mitigation/Adaptation:**

mitigation or adaptation strategy is a focus of resource

Adaptation

## **Model/Methodology:**

type of model used or methodology development is a focus of resource

Exposure Change Prediction

## **Resource Type:**

format or standard characteristic of resource

Research Article

## **Timescale:**

time period studied

Medium-Term (10-50 years)

## **Vulnerability/Impact Assessment:**

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content